ACTIVITY OF RADIO-TAGGED BLACK-FOOTED FERRETS

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Abstract.—Activity of two radio-tagged black-footed ferrets (*Mustela nigripes*) was investigated during October-November 1981 (an adult male monitored for 16 days), and during August-November 1982 (a young female monitored for 101 days). Aboveground activity of the male averaged 2.95 hr/night, 15% of the total time monitored. From 22 September to 5 November, aboveground activity of the female averaged 1.9 hours; 26% of the time she was stationary and 74% of the time she was moving. During August the juvenile female emerged at least once on 93% of the nights. She was least active in November. Both animals were primarily nocturnal (although daylight activity was not uncommon), and timing of nightly activity was similar, peaking from 0100 to 0359.

The discovery of a population of black-footed ferrets near Meeteetse, Wyoming, in 1981 (Schroeder and Martin 1982), provided an opportunity to investigate the behavior of this rare animal. We collected activity data on an adult male ferret radio-monitored during fall 1981, and a juvenile female ferret radio-monitored during late summer and fall of 1982. Spatial aspects of the activity of these two ferrets were summarized by Biggins et al. (1985); this paper addresses temporal elements of activity.

The timing of ferret activity and attendant causes has intrinsic value; however, the topic is also critical to refining spotlighting as a tool in ferret research and management (Campbell et al. 1985). Spotlighting success can be improved by knowing the time of year and time of night when ferrets are most active. Our small sample provides the first quantitative assessment of wild black-footed ferret time-activity patterns using radio telemetry.

Study Area and Methods

Black-footed ferrets occur on a 3000 ha complex of white-tailed prairie dog (*Cynomys leucurus*) towns near Meeteetse, Wyoming. The site is a short-grass prairie at elevations ranging from 2000 to 2300 m. Vegetation and other site characteristics are described by Collins and Lichvar (1986) and Clark et al. (*Description and history*, 1986).

Ferrets were captured in Sheets' (1972) cylindrical trap and immobilized with ketamine hydrochloride. Animals were fitted with a 15–g transmitter collar and allowed to recover fully from anesthesia before release. Descriptions have been given of trapping and handling procedures (Thorne et al. 1985) and of development of the transmitter packages (Fagerstone et al. 1985). Ferrets were radio-tracked from 30 October to 14 November 1981 (the male) and from 13 August to 30 November 1982 (the female). Telemetric monitoring was continuous during 16 October–5 November 1982; for other periods monitoring was mostly during the hours of darkness. Radio-tracking in 1981 consisted primarily of simple signal-following with hand-held Yagi antennas. We recorded time the male ferret spent above and below ground, but we did not attempt to separate aboveground activity into "moving" or "stationary" categories. Hand-held antennas were again employed in 1982, but most radio-tracking involved triangulation from pairs of mobile tracking stations (Biggins et al. 1985). The refined techniques and equipment allowed three types of signal status (involving strength and constancy of direction) to be telemetrically correlated with different activities: (1) changes in bearing indicated that the animal was moving aboveground, (2) consistent bearings with audible signal indicated that an animal was near or on the surface but relatively stationary, and (3) sudden loss of signal usually occurred when the animal went underground. We were able to describe daily

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and seasonal changes in activity of the female from the 101 days of monitoring in 1982; however, the limited detail and short (16-day) radio-tracking period made the data on the male best suited for only general comparisons with the female.

To avoid semantic confusion, we developed the following definitions:

period = a seasonal time category, measured in days, resulting from subdivision of the year.
interval = a time category, measured in minutes or hours, resulting from subdivision of the day.
bout of activity = a session of ferret activity occurring aboveground (or mostly aboveground), lasting >20 min and separated from other such bouts by ≥ 1 hr.

Data were summarized by tabulating presence or absence of received signal in time intervals. For overall seasonal analysis of activity data on the female, a day was divided into 48 0.5-hr intervals. For each interval, the following questions were asked and positive responses recorded: (1) Was the animal telemetrically monitored during this period? (2)Was the signal absent during any part of the period? (3) Was the signal present during any part of the period? (4) Was the animal moving during any part of the period? (5) Was the animal stationary for at least part of the time? With this approach, it was possible (but uncommon) to have each category of activity present in a single monitoring period. Therefore, the resulting frequency data is not additive between categories; e.g., the total number of intervals with audible signal is usually not the sum of intervals containing movement and intervals containing stationary activity.

Relative importance of stationary and movement activity for the female ferret was determined by contingency table analysis using four rows of seasonal periods and two columns that represented the number of 0.5-hr periods in which the number of days with movement exceeded the number of days with stationary activity and vice versa. Only the 21 periods from 1930 to 0600 (roughly sunset to sunrise) were included because the sample size of monitoring periods during other times of the day was too small for some seasonal periods (≥ 10 days of monitoring were deemed necessary).

The seasonal emergence times of the female were compared by splitting nights (sunset to sunrise) into equal quarters to tally emergences. For a seasonal period, length of quarters was the average amount of time between sunset and sunrise during that period divided by four, quarter length being longer later in the season. Only emergences for bouts of activity as defined above were considered.

Activity for the female and male from 30 October through 13 November was compared using total minutes of aboveground activity within 3-hr intervals and for each night. When gaps in monitoring occurred in either data set, corresponding time periods were deleted from both sets. This procedure allows a comparison of two animals monitored for exactly the same time periods but during two different years. Standard Chi-square tests for goodness-of-fit, Chi-square tests of independence (contingency table analysis), and t-tests were used to evaluate statistical significance of relationships, with the rejection level established at $P = 0.05$. Times are indicated on the basis of the 24-hour clock and Mountain Standard Time (MST).

RESULTS

General Activity Patterns of the Female Ferret

During 23 September-5 November, 39 bouts of activity by the female ferret were monitored in entirety (from first appearance of radio signal to final disappearance). The average length of a bout was 1.9 hr, and an 11.7-hr bout on 27 September was the longest. During that bout, movements occurred only during the first and last hours and were separated by 9.7 hr of stationary time during daylight. Stationary time ranging from 0.1 to 9.7 hr often preceded movement (20 occasions) or followed movement (13 occasions). Movement composed 74% of 1,569 min of activity sampled 30 October-13 November.

Daily and Seasonal Activity Patterns of the Female Ferret

From August through mid-September, the female ferret was in transition from "a social and dependent young animal to a relatively solitary and independent individual" (Biggins et al. 1985). In October and November her behavior may have differed from that of adult

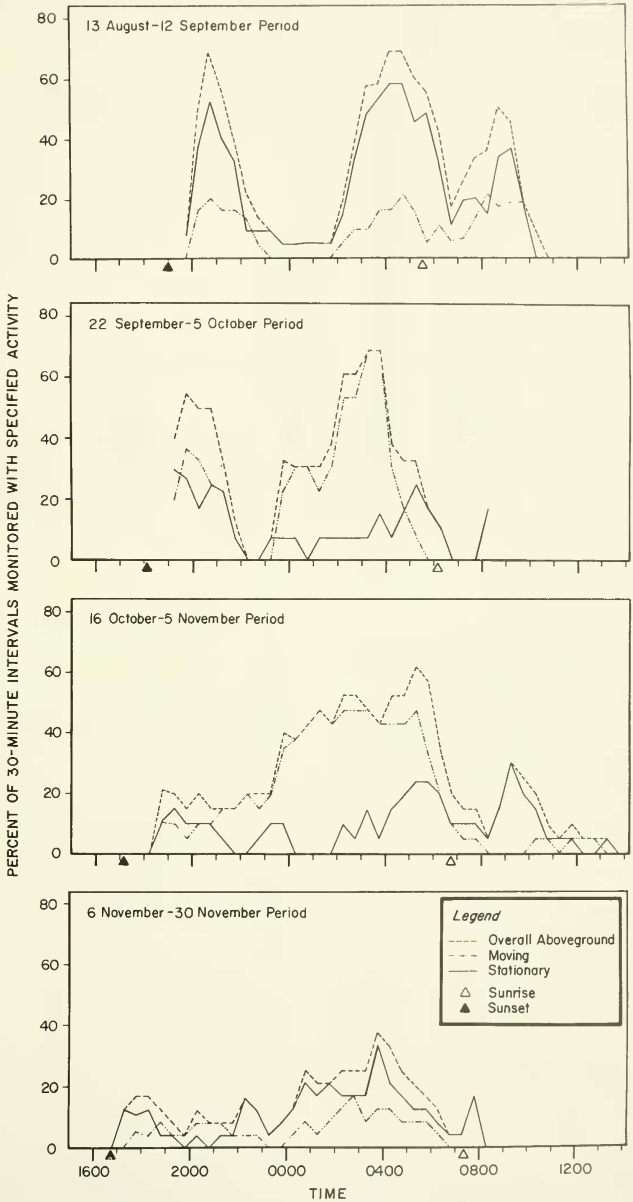

Fig. 1. Activity of a female black-footed ferret during 4 seasonal periods.

females with established home ranges and presumably better hunting skills.

The female was most active in the 13 August–12 September and 22 September–5 October periods, with > 2/3 of the days in five 30–min intervals containing aboveground activity. In the 6–30 November period, no 30–min interval had aboveground activity for more than 37% of the days monitored. Peaks in overall aboveground activity occurred within the four intervals from 0230 to 0429 in all four seasonal periods. The lull in all types of activity from about noon to sunset was similar to behavior of South Dakota ferrets (Hillman 1968). However, the female was active at least once during each hourly interval of day and night at some time during the study. (Activity does not appear in the noon to sunset interval on any graph because of the sample size restriction mentioned.) Most daylight activity of the female occurred within the five hours following sunrise. Similar behavior was observed in unmarked ferrets in the Meeteetse area (Clark et al. *Descriptive ethology*, 1986) and was noted in South Dakota (Hillman 1968). Morning activity was especially frequent during the 13 August–12 September period (Fig. 1). The female was active from 0830 to 0859 on half the days monitored during this period. The morning peak remained in the 16 October–5 November period but was delayed, perhaps due to later sunrise.

From 14 to 28 August the female (and her litter-mates) could be characterized as active and predictable. She had at least one bout of activity on 14 of 15 days (93%). She had a second bout on 8 days (53%) and a third bout on 5 days (33%,). On 11 of the 15 nights, she emerged between 1910 and 2005, shortly after sunset. On 6 of the 15 nights, she emerged between 0050 and 0210 for either the first or second bout, and all five of the third bouts were in the interval 0616–0730 (at least 0.5 hr after sunrise). Over 80% (22 of 27) of all emergences occurred within the three intervals listed above. The prominent bimodal peaks of night activity during the period when the female was part of a litter (Fig. 1) progressively changed to a more uniform distribution of activity by November. Hillman (1968) and Clark et al. (*Descriptive ethology*, 1986) also found a bimodal distribution in ferret activity, but timing differed. Comparison with these data is difficult, because Hillman's (1968) summary covered the entire period from April through November and the information of Clark et al. (*Descriptive ethology*, 1986) covered July-August.

As implied by the seasonal depictions of activity (Fig. 1), emergence times for bouts of activity were not equally distributed through the night. When nights were split into quarters, significant departures from equal numbers of emergences each quarter were noted in two of the four seasonal periods (Chi-square goodness-of-fit, d.f. = 3; 13 August–12 September, X^2 = 13.45, P = 0.004; 22 September–5 October, X^2 = 5.78, P = 0.123; 16 October–5 November, X^2 = 2.429, P = 0.488; 6–30 November, X^2 = 11.35, P = 0.010). The female emerged more than expected in the first and third quarters during the 13 August–12 September periods, and in the 6–30 November period she emerged more in the third quarter than in the other three quarters combined (13 of 23 times). Seasonal changes in proportions of emergences in each quarter of the night were also significant (4 season by 4 quarter contingency table, X^2 = 23.71, P = 0.005).

Relative amounts of stationary and moving types of activity changed with seasonal progression and maturity of the female. She tended to make short movements or no movement late in the summer (13 August–12 September)(Fig. 1). This phenomenon again appeared in late fall (6–30 November), but at that time of year all types of activity were infrequent. The shift in importance of movement versus stationary time is reflected by the seasonal change in frequency of each in the 21 0.5–hr time intervals from 1930 to 0600. Movement activity peaked during the 16 October–5 November period when frequency of movement exceeded the frequency of stationary activity for 18 of 21 time intervals. The decrease in movements during the next period was dramatic; only 4 of 21 intervals had higher movement frequencies. The overall seasonal change in relative amounts of movement and stationary activity was highly significant (4 season by 2 activity contingency table, X^2 = 37.68, $P < 0.0001$).

Ferrets appeared to be relatively inactive during 6–30 November 1982. Few observations of ferrets were made during spotlight surveys, and little ferret sign (diggings or

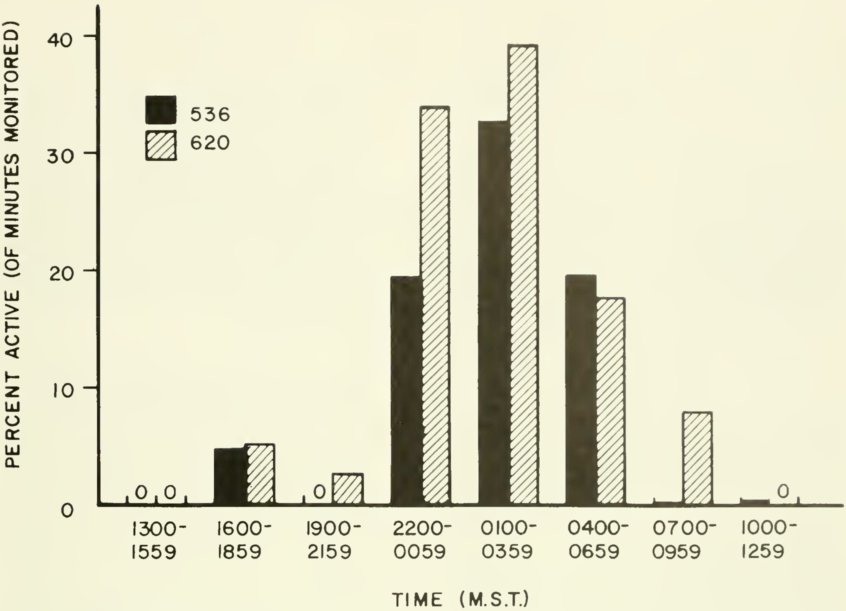

Fig. 2. Total aboveground activity of a female (No. 536) and a male (No. 620) black-footed ferret, 30 October-13 November.

tracks on snow) could be found. The radio-tagged female did not emerge during hours of darkness for 5 consecutive nights in mid-November.

Comparison of the Male and Female Ferrets

From 30 October to 13 November, daily activity patterns of the two ferrets were similar (Fig. 2). Neither animal was active from 1300 to 1559, both animals had a small amount of activity near sunset followed by decreased activity from 1900 to 2159, and both animals reached peak activity from 0100 to 0359. During 14,318 min of monitoring on each animal, the signals from the female and male were audible for 1,569 min (11%) and 2,125 min (15%), respectively. Average amounts of total time spent aboveground nightly were 2.10 hr for the female (range 0–5.79 hr) and 2.95 hr for the male (range 0–4.84 hr). These figures and the patterns illustrated in Figure 2 suggested that the adult male was more active than the young female, but we could not detect a significant difference in average nightly activity ($t = 1.044$, $P = 0.308$). Durations of nightly activity of the female were mostly short; half were < 0.75 hours, with no activity on 3 of the 12 nights. There were 3 nights with > 5 hours of activity. In contrast, the male was never active for > 4.84 hours and was completely inactive for only 1 night; he accumulated 3.24–4.84 hours of activity on 7 of the 12 nights monitored.

Discussion

Few general conclusions can be derived from the comparisons between these two animals, because data came from a different year for each animal, sexes and ages were different, and 12 nights is a small sample. However, we can hypothesize that male ferrets are more active than females. This hypothesis is consistent with comparisons of spatial activity of these two animals; the area of activity of the male was more than twice as large as that of the female (Biggins et al. 1985). Males of other small mustelid species also use larger areas than females, based on information about stoats (*Mustela erminea*) (Erlinge 1977, Simms 1979), feral domestic ferrets (*M. furo*) (Moors and Lavers 1981), and weasels (*M. nivalis* and *M. erminea*)(Lockie 1966).

Our preliminary study has provided detailed information on only one animal during four months, and on a second animal for a much briefer period. The descriptive statistics were compiled to emphasize some behaviors detected in this species. We do not know whether these examples typify ferret activity in general, although our data support certain observations of others (Hillman 1968, Clark et al. *Descriptive ethology*, 1986). Abundance and activity of prey, breeding activity, and weather may influence ferret activity. Richardson (personal communication) found a positive correlation between temperature and movements of snow-tracked ferrets and found increased movements during the breeding season.

Seasonal changes observed in the radio-tagged female ferret imply that procedures used to locate ferrets (e.g., spotlighting) may not be generalized throughout the year. Our data suggest that the best time of night to conduct spotlight searches for ferrets from August through mid-October is from 0200 (MST) until dawn. This agrees with information collected by Clark et al. (*Descriptive ethology*, 1986) on activity of ferret litter groups in summer. Future analyses of more recent telemetric data may help identify causes of seasonal changes in activity.

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